

## The industry effects of monetary policy in Spain

Rodríguez-Fuentes, Carlos; Padron-Marrero, David

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## The industry effects of monetary policy in Spain

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The industry effects of monetary policy in Spain

Carlos J. Rodríguez-Fuentes

Department of Applied Economics  
University of La Laguna  
Campus de Guajara - 38071  
S/C de Tenerife - Spain  
Email: cjrodrig@ull.es

David Padrón-Marrero

Department of Applied Economics  
University of La Laguna  
Campus de Guajara - 38071  
S/C de Tenerife - Spain  
Email: dpadron@ull.es

Abstract

The aim of this paper is to analyze the presence of sectoral asymmetries in monetary policy transmission in Spain in the period prior to the introduction of the single monetary policy in Europe (1988-1998). Monetary policy shocks are identified both through a standard vector auto-regression model (VAR-shock) and the specification of a reaction function (RF-shock) for the monetary authority in Spain. The responses of the different industrial branches with regard to the estimated monetary shocks are then analyzed at national accounting sector and sub-sector levels. Our results confirm the presence of significant differences in the sectoral responses with respect to national monetary shocks in Spain. In addition, the sectoral asymmetries found in our study show a strong correlation with regard to the regional asymmetries found in a previous study.

Key words: monetary policy; industry effects; monetary shocks; Spain

JEL: E52 Monetary policy (targets, instruments and effects); L60 Industry Studies: Manufacturing (general)

## 1. Introduction.

The study of the transmission mechanism of monetary policy has traditionally focused on the aggregate level of the economy, specifically on the impact of monetary policy decisions on production and price levels. Nevertheless, the last decade has seen an increasing amount of research which concentrate on the study of asymmetries which can arise in the transmission of national monetary shocks, either in specific regions which make up the national economy (regional asymmetries), or among their respective productive sectors (sectoral asymmetries). Undoubtedly a significant portion of this literature is motivated by the loss of monetary sovereignty which some European Union (EU) countries have experienced as a result of their conversion into regions within the eurozone. These countries have all irreversibly lost their prior “national monetary identities” and as such have begun to be concern about the regional repercussions of the European Central Bank’s monetary policy (Rodríguez Fuentes 2005: 5-7).

The growing interest in the study of sectoral asymmetries in the transmission of monetary policy has also been stimulated by the forecast that the establishment of a single currency in the European Union would convert *sectoral* shocks in truly *regional* shocks (Krugman and Venables 1996), which in turn would lead to regional tensions in the process of European integration.<sup>1</sup> This forecast has also been reinforced by some empirical evidence in studies which emphasize the importance of the differences in the regional productive structure in the explanation of the different regional responses with regard to national monetary policy shocks (see, among

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others, Carlino and DeFina 1996, 1998a, 1998b and 1999, Guiso et al. 1999 and Arnold, 2001).

This paper analyses sectoral asymmetries in the transmission of national monetary shocks in Spain and also explores possible relationships among estimated sector shocks with the estimated regional shocks from an earlier one (Rodríguez Fuentes et al. 2004).

The paper is divided into an introduction, four main sections and conclusions. The body of the paper begins with a brief review of the empirical literature concerning sectoral asymmetries in monetary policy transmission. The responses of the different branches which make up the industrial sector in Spain are then studied in the next two sections. Section 3 introduces the estimates of monetary policy shocks in Spain for the period 1988-1998. It is well known that the estimation of monetary shocks is a critical step in any study which attempts to analyze the effects of monetary policy, and that the observed correlations between interest rates, output and prices can be due to an inverse causation process. Consequently the exogenous component (monetary shocks) must be isolated from its endogenous response. A VAR model is used to identify these shocks. Most empirical literature employs the VAR model when studying the monetary transmission mechanism. However our study does not end with just the VAR model. In addition we estimate a reaction function for the Bank of Spain in order to compare the robustness of the results obtained from our VAR model. This new approach can be used, in our opinion, as a complement to the traditional VAR literature. Section 4 studies the response of industrial production (by

sector and sub-sector) with regard to the estimated monetary policy shocks from the previous section.<sup>2</sup> Our results confirm the presence of important differences in the sectoral responses with respect to national monetary shocks in Spain and are consistent with available empirical evidence of other countries. In addition the sectoral asymmetries presented in this section show some similarities with the regional asymmetries found in a previous work (Rodríguez Fuentes et al. 2004) since the classification of the Spanish regions according to their implicit sectoral sensitiveness reflect a strong correlation with the ordering which is obtained by using their sensitivity when taking into account national monetary shocks (regional asymmetries).

## **2. Sectoral asymmetries in the transmission of monetary policy: an overview of the empirical literature.**

A review of the literature on the sectoral effects of monetary policy based on empirical evidence, leads to three important conclusions. Firstly, the choice of the VAR model as the econometric technique to identify monetary shocks. Secondly, that the strategy followed to value the measure of heterogeneity in the sectoral response consists in estimating a VAR model for each one of the sectors studied. This strategy leads to estimating as many reaction functions as sectors that are considered in the study and, consequently, obtaining a series of different monetary shocks<sup>3</sup> for each one of the studied sectors (which hinders the validity of intersectoral comparisons). The third conclusion is that most studies tend to incorporate among the endogenous variables both national and sectoral variables (production and price levels). In this case it is more common that national aggregates are placed ahead of

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the monetary policy variable, while sectoral variables appear after that variable (see Ganley and Salmon 1997 and Dedola and Lippi 2000 and 2005). This consideration and the use of recursive identification methods (Cholesky decomposition method) lead to the inclusion of the implicit assumption that monetary shocks do not have a contemporaneous impact on national aggregates but do have an instantaneous effect on sectoral variables, which could be interpreted as an inconsistency in the model.<sup>4</sup>

This analysis is found in the paper by Ganley and Salmon (1997) which studies the responses of different production sectors with respect to monetary policy shocks in the United Kingdom. This study estimates 24 VAR models (one for each one of the sectors under study) which incorporate, as endogenous variables, short term interest rate, the real GNP of the United Kingdom and its implicit deflator and, lastly, the production index of each sector. The Cholesky decomposition method is used with the variables ordered according to their previously mentioned description. Results from the study indicate that monetary policy measures implemented by the Bank of England have had varying impacts according to sectors. Examples can be found in the construction sector, and to a lesser extent, in manufacturing, where both sectors are subject to stronger and more rapid responses to national monetary shocks. In addition, the authors confirm large variability in the response to each one of branches that make up the manufacturing sector. For instance there are cases where some branches offer a very weak response (industries linked to non-durables consumer expenditures, as producers of food, drink and tobacco, textiles and footwear), while other industries (industries supplying construction, as glass, tiles, concrete and bricks, and

wood products; or industries linked to durables consumer expenditures, as vehicle manufacture) react in a very clear manner.

Results obtained by Hayo and Uhlenbrock (2000) also suggest the presence of important sectoral differences in their responses to national monetary shocks in West Germany. Their findings show that approximately half of the analyzed branches show a different response than the average one for the sector.

Dedola and Lippi (2000 and 2005) focus on the responses of industrial production in five countries belonging to the OECD. They study the production sector response of 21 industrial branches in Germany, France, U.S., Italy and the United Kingdom by using a common specification in the estimated VAR models. The results from these papers indicate that the differences among sectoral responses with respect to monetary shocks are much greater than those found in other countries. The authors also investigated if the observed sector heterogeneity in the response to national monetary shocks was due to industry-specific factors or country-specific factors. They conclude that sectoral responses were similar among all of the different countries studied. Their results also show that the impact of monetary shocks is greater in production industries including durable goods, which place greater demands on working capital and smaller borrowing capacity (Dedola and Lippi, 2005: 1565).

As noted earlier, most of the empirical studies which analyze sectoral effects of monetary policy tend to employ a VAR model to estimate each sector's response.



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This decision also assumes that national variables are not instantaneously affected by monetary shocks whereas the sectoral variables are, which could be interpreted as an inconsistency in the model. Various alternatives have been proposed to address this inconsistency. One is seen in Raddatz and Rigobon (2003), where the authors suggest estimating a single national VAR model, where national production is substituted by the production levels in each sector under consideration. These authors also introduce a non recursive identification method which allows them to sort the obstacle, namely that monetary shocks do not have a contemporaneous effect on national variables but do have an instantaneous effect on sectoral variables. Even so, the results obtained by Raddatz and Rigobon (2003) also suggest the presence of important sectoral asymmetries in the responses from different industrial branches in the U.S. economy with respect to national monetary policy, where durable goods and property investment are the two sectors that show the strongest response. Nevertheless, the approach by Raddatz and Rigobon (2003) is not problem-free. For instance, the complete identification of all structural parameters of the model requires several assumptions. In addition the large number of estimated parameters creates an important reduction in the degrees of freedom, a sensitive issue when working with short time series.

Peersman and Smets (2002) propose a two-step strategy to value sectoral asymmetries in monetary policy transmission in the euro zone. The first stage is carried out by extracting monetary shocks from the estimates derived from a VAR model for the national economy. The estimated national monetary shocks from the first stage are then used in the second stage to explain the behaviour of the sectoral

production based upon its past behaviour and estimated national monetary shocks from the prior stage. These estimated national monetary shocks will be equal for each one of the studied sectors since they have been extracted from the national VAR model.

We begin our study by incorporating the strategy used in Peersman and Smets (2002) but will also estimate national monetary shocks by using the specification of a reaction function for the Bank of Spain.

### 3. Identification of monetary shocks: VAR models and reaction functions.

Following the current orthodox empirical literature on monetary policy (Christiano et al. 1999), we have identified the exogenous monetary shocks by means of a VAR model and a reaction function of the central bank.<sup>5</sup> This second approach is, in our opinion, a novel contribution in the context of empirical literature regarding sectoral asymmetries in the transmission of monetary policy. Details of the specification of the VAR model as well as the reaction function follow.

#### 3.1. VAR Model

The general equation of the VAR model that we have chosen to identify the monetary policy shocks Spain is of the form:

$$\begin{bmatrix} X_t \\ Y_t \end{bmatrix} = \begin{bmatrix} A(L) & B(L) \\ C(L) & D(L) \end{bmatrix} \begin{bmatrix} X_{t-1} \\ Y_{t-1} \end{bmatrix} + \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} e_t^x \\ e_t^y \end{bmatrix} \quad (1)$$

where  $Y_t$  is the vector containing the endogenous variables of the system, all of which refer to the set representing the national economy. This set is made up of these

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variables in the following order, national industrial production index (IPI), the consumer price index (CPI), the German inter-bank interest rate ( $i_{AL}$ ), the M3 monetary aggregate, the interest rate for three month non-transferable deposits ( $i_{ESP}$ ) and the real effective exchange rate for the peseta (REER).<sup>6</sup>

$$Y_t = [IPI_t \quad CPI_t \quad i_{AL} \quad M3 \quad i_{ESP} \quad REER]' \tag{2}$$

We have also introduced an exogenous variable vector which includes a constant (const), a tendency (trend), and a world commodity price index (WCPI) to control possible external shocks.

$$X_t = [const \quad trend \quad WCPI_t]' \tag{3}$$

The VAR model has been estimated in levels, which allows us to control the possible existence of cointegration. Almost all variables are expressed in logarithmic form, the exception being the interest rates. Data have been taken from the Monthly Statistical Bulletin of the Bank of Spain and the sample covers the period from January, 1988 to December, 1998.<sup>7</sup> The lag structure used in the model is two months, and the monetary policy shock that we have identified is a result of the Cholesky decomposition method, with the variables defined and ordered according to our earlier comments.<sup>8</sup>

Graph 1 depicts the impulse-response function of the most important variables, namely production and prices. This graph indicates that prices remain unaltered after an unexpected monetary policy shock, which could be justified by the high levels of

price (and nominal wages) rigidity that have been traditionally seen in the Spanish economy. The case of production, however, is consistent with other studies, where monetary policy reaches its maximum impact on production on the seventh month after the unexpected monetary shock took place.

Graph 1 NEAR HERE

### 3.2. Reaction function

The VAR methodology has played an important role in the empirical analysis concerning the impact of monetary policy actions on economy. Even so it has been questioned not only in its method for retrieving monetary shocks but also with the problems associated with capturing the forward-looking behaviour which modern monetary policy theory attributes to central banks (Clarida et al. 1999 and Svensson 1999). Under this scenario, the monetary authority considers the expected evolution of the relevant economic aggregates in the near future while making decisions in the present. This approach has grown in favour among a number of authors when evaluating the actions of central banks, and can be adapted to its inclusion in the specification of a reaction function for the monetary authority.

For this reason we also decided to estimate a reaction function for the Bank of Spain where the unexpected monetary shock is identified with the unexplained observed interest rates by deriving rates based on the estimated reaction function.

The reaction function that we estimated has the following form:

$$i_t = \rho i_{t-1} + (1 - \rho) [\alpha + \beta \pi_{t+k} + \gamma x_{t+p} + \lambda Z_t] + \varepsilon_t \quad (4)$$

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where  $\pi$  is the interannual inflation rate,  $x$  is the output-gap, and  $Z$  represents a set of variables which can affect interest rate decisions, independently of its explanatory power on inflationary trends and the output-gap, which include the exchange rate and a foreign interest rate. Our model specification includes the peseta/mark nominal exchange rate and the German three month interest rate.

The proposed reaction function is a simple combination of a Taylor Rule type reaction function (Taylor 1993) and a first order partial autoregression rule. The Taylor Rule reaction function incorporates the forward-looking behaviour assumption for the monetary authority (under the assumption of rational expectations). The autoregression rule captures demonstrated tendencies by central banks to smoothen interest rate changes.

The resultant reaction function was estimated by the Generalized Method of Moments (GMM) by taking advantage of the following set of orthogonal conditions:

$$E[\varepsilon_t / \Omega_t] = E[i_t - \rho i_{t-1} - (1 - \rho)[\alpha + \beta \pi_{t+k} + \gamma x_{t+p} + \lambda Z_t] / \Omega_t] = 0 \tag{5}$$

Possible problems of heterokedasticity and autocorrelation led us to use the Newey and West method when calculating standard errors. The Hansen J statistic was also calculated to control possible overidentification. Table 1 shows that the best results were obtained by the forecast horizon  $k=6 \cap p=3$ . In addition we decided to omit the peseta/mark nominal exchange rate since changes in the variable were not statistically significant in any of the tested specifications.

Table 1 NEAR HERE

Graph 2 compares the accumulated monetary shocks obtained from VAR models with those derived from the reaction function. The resultant time profiles indicate that both series are quite similar, leading to an interpretation of favourable evidence regarding the robustness of our results. It is also worth mentioning the presence of a strong relationship between the shown path from the accumulated shocks and the short term interest rate. Consequently in the periods where the short term interest rate increases contracting shocks are seen, as in the opposite case for falling rates. Nevertheless, from 1996 to 1997 this relationship seems to stray from this trend. If this is the case these actions could be interpreted as deliberate actions by the Bank of Spain to tighten monetary policy and thus exercise stricter control on the inflation rate and satisfy the Maastricht criteria.

Graph 2. NEAR HERE

#### 4. Sectoral asymmetries in the transmission of monetary shocks.

Following Peersman and Smets (2002), we study the industry effects of monetary policy shock in Spain<sup>9</sup> by using the following expression which relates the trends from the production activity from each industrial branch with its past behaviour and the estimated accumulated monetary shock from the prior section:

$$ipi_{i,t} = \alpha_i + \sum_{j=1}^{12} \beta_i \cdot ipi_{i,t-j} + \gamma_i \cdot shock_{t-1} + \eta_{i,t} \quad (6)$$

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where  $ipi_{i,t}$  is monthly growth rate of the Industrial Production Index (IPI) of branch  $i$ ,  $shock_{t-1}$  is the accumulated monetary policy shock estimated previously (VAR-shock and RF-shock) and  $\eta_{i,t}$  is an error term. Given the possibility of instantaneous correlation between the different Spanish industrial branches, expression (6) has been estimated using the SUR (Seemingly Unrelated Regressions) method.

Table 2 summarizes the estimated values from the response of the different industrial sections in Spain with respect to a monetary shock ( $\gamma_i$ ). This table indicates that the production response with respect to an unexpected monetary shock is generally negative. Another aspect which deserves our attention is the presence of clear similarities among the obtained results for both VAR and RF shocks. These results suggest that the contraction in production is greater among mining industries (section C), while section E (Electricity, gas and water supply) are found at the opposite extreme. However, the low statistical significance of the estimates for this disaggregated level (sections) should be highlighted, since only the estimated response for the mining industries from the RF-shock were seen to be statistically significant.

Table 2. NEAR HERE

The lack of statistical significance from the obtained results at the section level of industrial activity could be attributed to the presence of distinct behaviour among the activity branches (subsections) which make up the different industrial sections. We

therefore proceed to analyze the sectoral responses at the subsection level, with the results shown in table 3.

The estimated parameters are generally characterized by an expected negative sign, indicating the (unexpected) tightening of monetary policy resulting in a contraction of the different industrial branches under study. The results also indicate once again that estimated parameters from the RF-shock are greater (in absolute value) than those obtained from using the VAR-shock, in addition to having greater statistical significance. Although there is a greater level of disaggregation in these estimates, the comparison between the obtained sectoral responses from both VAR and RF shocks allow us to offer some conclusions. Firstly, that subsection EA (electricity, gas and water supply) once again is seen as one of the branches least sensitive to monetary shocks, as in the case at the section level. Other branches also appear, such as the manufacture of food products, beverages and tobacco (subsection DA), as well as the manufacture of leather and leather products (subsection DC), the paper industry (subsection DE) and the manufacture of coke, refined petroleum products and nuclear fuels (subsection DF). Another observation is that the greater sensitivity to national monetary shocks would take place in machinery and mechanical equipment (subsection DK), the mining and quarrying of energy producing material (subsection CA) and the mining and quarrying of other minerals (subsection CB).

Table 3. NEAR HERE



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Some important differences need to be mentioned when comparing the results from the obtained estimates from the reaction function (RF-shock) and the VAR model (VAR-shock). The first difference concerns the DM (Manufacture of transport equipment) and DJ (Manufacture of basic metals and fabricated metal products) subsections. While high sensitivity is observed with respect to estimated monetary shocks based on the reaction function (RF-shock) of these subsections, the VAR-shock produces much lower sensitivity. A second difference occurs in the different manufacturing industries (subsection DN), where slight sensitivity with respect to estimated monetary shocks based on the VAR model are noted (VAR-shock). Nevertheless, the estimated response for the reaction function (RF-shock) ranks this section in an intermediate position among all sectors.

The presence of sectoral asymmetries in the transmission of monetary policy has obvious direct implications at the regional level. Indeed, given that Spanish regions show important differences in industrial specialization, the presence of different sectoral responses with respect to monetary policy impulses in Spain could convert the sectoral shocks into regional ones. With the purpose of studying the link between sectoral asymmetries and regional asymmetries in Spain, we calculated an index of regional sensitivity (ISR-1)<sup>10</sup> which, hypothetically, would reflect the sensitivity of each Spanish region with respect to the monetary shocks based on the industrial specialization profile. The comparison between this index, which reflects the regional sensitivity due to the region's industry-mix, and the regional response with respect to national monetary policy shocks<sup>11</sup>, which we estimated in an earlier work, indicates the presence of a high degree of correlation between regional and sectoral

asymmetries in Spain (graph 3), which is consistent with the traditional literature regarding the interest rate transmission mechanism. Nevertheless, this correlation is far from being perfect, so it seems reasonable that other factors different to the sectoral-mix, such as those related to the financial structure and behaviour (see Rodríguez Fuentes et al. 2004: 260-262), may also have played a relevant role in the explanation of regional asymmetries in the transmission of monetary shocks in Spain.

Graph 3. NEAR HERE

#### 4. Conclusions.

This paper has studied sectoral asymmetries in the transmission of monetary policy shocks in Spain in the period immediately prior to the establishment of the single monetary policy (1988-1998). The identification of the monetary shocks was carried out through the estimate of a VAR model and the specification of a reaction function for the Bank of Spain. The monetary shocks obtained were then employed to study the degree of sensitivity of the different activities that make up the industrial sector in Spain. Our results are consistent with those available for other countries (Ganley and Salmon 1997, Dedola and Lippi 2000 and 2005, Hayo and Uhlenbrock 2000, Peersman and Smets 2002 and Raddatz and Rigobon 2003), namely the presence of important differences in sectoral responses with respect to national monetary shocks in Spain. In addition, the sectoral asymmetries found in our study show a strong correlation with the regional asymmetries found in a previous study (Rodríguez Fuentes et al. 2004). In particular, the resultant classification from ordering Spanish regions according to the sensitivity of different industrial branches which make up

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their respective industrial GDP reveals a high correlation with the ordering that is obtained by using sensitivity with respect to national monetary shocks (regional asymmetries). We can conclude from our results that at least during the period 1988-1998, differences in industrial specialization are an important explanatory factor for the regional asymmetries in the transmission mechanism of monetary policy in Spain. However, aside from the fact that the correlation among sectoral and regional shocks is less than one, we could also conclude that the explanation of the regional differences with respect to national monetary shocks requires the inclusion of different factors not found in regional productive specialization. Such factors would include those related with the dimension and financial structure of the regional business and financial sectors, as well as the levels of competition (both internal and external) which are present in each sector.

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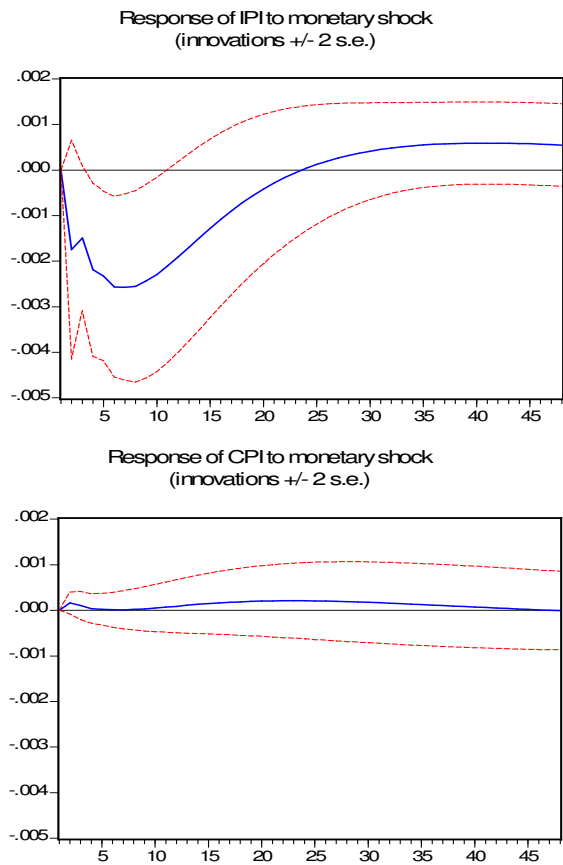
## APPENDIX

Table A.1. Sectoral and regional asymmetries of monetary policy in Spain

	ISR-1	ISR-2
Andalucia	0,58	0,22
Aragon	0,99	0,60
Asturias	0,83	0,52
Baleares	0,39	0,12
Canarias	0,39	0,28
Cantabria	0,70	0,56
Castilla-Leon	0,74	0,77
Castilla-Mancha	0,67	0,06
Cataluña	0,70	0,60
Extremadura	0,34	0,17
Galicia	0,76	0,48
Madrid	0,62	0,38
Murcia	0,63	0,26
Navarra	1,00	0,68
Pais Vasco	0,95	0,77
Rioja	0,66	1,00
Valencia	0,69	0,60
Correlation coefficient	0,394	
<p>ISR-1: This index is the result of multiplying, for each region, the estimated sensitivity from the RF-shock (table 3) for each one of the industrial subsections by its respective participation in the regional industrial GDP in 1998. The values shown in the table are the result of diving each region's response by the maximum value.</p> <p>ISR-2: The index reflects the response of the regional industrial production to unexpected monetary policy from a reaction function for the Bank of Spain (further details in Rodríguez Fuentes et al. 2004: 260). The values shown in the table are the result of diving each region's response by the maximum regional response.</p>		

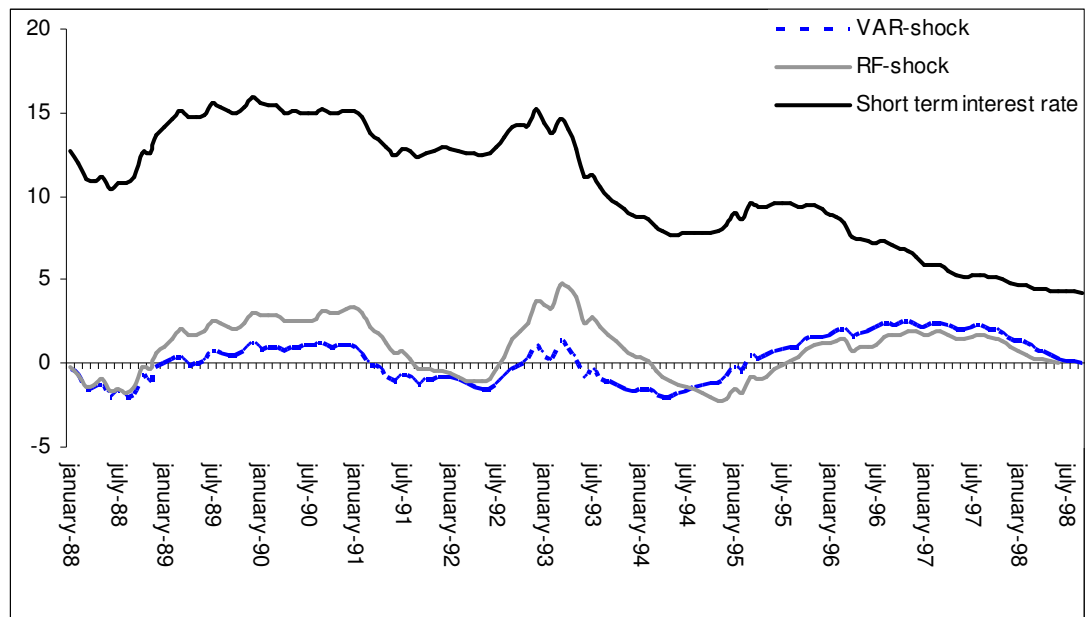


Graph 1. Function of impulse-response of industrial production (IPI) and prices (CPI) with respect to a monetary shock (one standard deviation)



Note: The estimates were carried out using Eviews.

Graph 2. Monetary shocks and short term interest rates in Spain



Graph 3. Sectoral and regional asymmetries

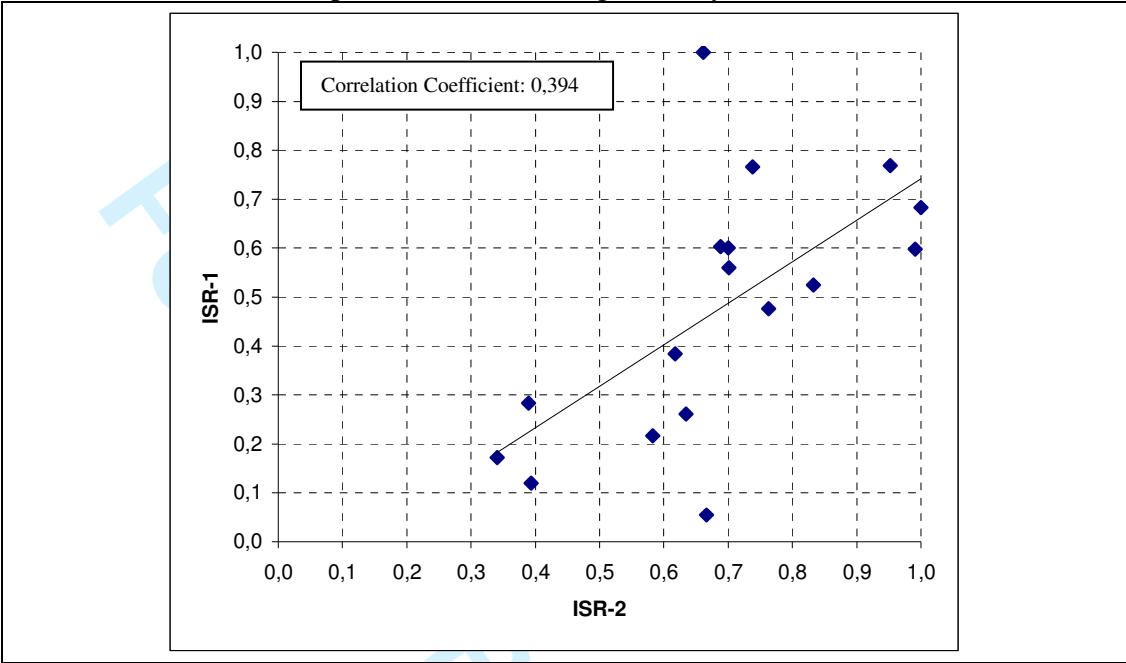


Table 1. Results from estimating the reaction function for the Bank of Spain

	k = 3 p = 3	k = 6 p = 6	k = 12 p = 12	k = 6 P = 3	k = 12 p = 3	K = 12 p = 6	k = 3 p = 3 Z = i <sub>AL</sub>	k = 6 p = 3 Z = i <sub>AL</sub>
$\rho$	0,905**	0,949**	0,973**	0,924**	1,006**	1,002**	0,898**	0,897**
$\alpha$	-0,485	-2,015	-0,249	-1,943*	33,049	81,290	-0,414	-1,204
$\beta$	2,054**	2,556**	1,532**	2,252**	-0,700	-4,583	1,895**	1,523**
$\gamma$	0,223**	0,088	-0,337*	0,423**	-2,662	-3,986	0,205**	0,226**
$\lambda$	-	-	-	-	-	-	0,122	0,561**
$R^2$	0,986	0,985	0,982	0,983	0,982	0,982	0,986	0,985
S.E.	0,419	0,424	0,444	0,458	0,439	0,443	0,419	0,433
J-test	17,12 [0,998]	17,32 [0,998]	16,69 [0,998]	17,60 [0,997]	17,22 [0,998]	17,39 [0,997]	16,99 [0,997]	17,75 [0,995]

Note: The estimates were carried out using Eviews.

\* and \*\* denotes that a variable is significant at the 5 and 1% level, respectively.

The following variables were used in the estimation: constant,  $i_{t-1}$ ,  $i_{t-2}$ ,  $i_{t-3}$ ,  $i_{t-4}$ ,  $i_{t-5}$ ,  $i_{t-6}$ ,  $i_{t-9}$ ,  $i_{t-12}$ ,  $\pi_{t-1}$ ,  $\pi_{t-2}$ ,  $\pi_{t-3}$ ,  $\pi_{t-4}$ ,  $\pi_{t-5}$ ,  $\pi_{t-6}$ ,  $\pi_{t-9}$ ,  $\pi_{t-12}$ ,  $X_{t-1}$ ,  $X_{t-2}$ ,  $X_{t-3}$ ,  $X_{t-4}$ ,  $X_{t-5}$ ,  $X_{t-6}$ ,  $X_{t-9}$ ,  $X_{t-12}$ ,  $q_{t-1}$ ,  $q_{t-2}$ ,  $q_{t-3}$ ,  $q_{t-4}$ ,  $q_{t-5}$ ,  $q_{t-6}$ ,  $q_{t-9}$ ,  $q_{t-12}$ ,  $m_{t-1}$ ,  $m_{t-2}$ ,  $m_{t-3}$ ,  $m_{t-4}$ ,  $m_{t-5}$ ,  $m_{t-6}$ ,  $m_{t-9}$ ,  $m_{t-12}$ . Where  $q$  is the change in the nominal peseta-mark exchange rate and  $m$  is the rate of growth in the M3 monetary aggregate. The table also shows the J-statistic and the probability of accepting the null hypothesis.

Table 2.- Response from different industrial branches with respect to a monetary shock ( $\gamma_i$ )

RF-shock			VAR-shock		
Section	Coefficient	t-statistic	Section	Coefficient	t-statistic
C	-1,260707	-2,648278	C	-0,665141	-1,641380
D	-0,490532	-1,509285	D	-0,229419	-0,973417
E	-0,025145	-0,103596	E	0,221215	0,869998
C (Mining and quarrying), D (Manufacturing) and E (Electricity, gas a water supply)					

Table 3.- Response by industrial subsections with respect to monetary shock ( $\gamma_i$ )

FR-shock			VAR-shock		
Subsection	Coefficient	t-statistic	Subsection	Coefficient	t-statistic
DA	0,107995	0,367364	EA	0,245455	0,968357
DC	-0,032593	-0,082099	DN	0,208370	0,460732
EA	-0,051506	-0,213997	DF	0,070817	0,185372
DE	-0,081628	-0,342259	DE	-0,033691	-0,139498
DF	-0,224908	-0,668028	DA	-0,090756	-0,293388
DG	-0,292967	-0,733748	DC	-0,095969	-0,228702
DI	-0,412020	-1,659494	DH	-0,276524	-0,644695
DN	-0,537933	-1,236804	DI	-0,314554	-1,506139
DL	-0,823875	-1,465081	DJ	-0,339709	-1,129706
DD	-0,861333	-1,646532	DM	-0,391174	-0,435383
DB	-0,948324	-2,477780	DL	-0,515330	-0,896411
DH	-1,088006	-2,424762	DG	-0,535510	-1,533995
DJ	-1,090333	-2,990396	DB	-0,551075	-1,706137
CB	-1,126873	-1,988770	DD	-0,630545	-1,298233
CA	-1,560122	-3,520476	CA	-0,715491	-1,580320
DK	-1,925580	-3,067467	CB	-0,819522	-1,629274
DM	-2,002185	-2,523202	DK	-1,111361	-2,136371
Wald test					
FR-shock			VAR-shock		
	Chi-square (probability)			Chi-square (probability)	
Total sample	34,60183 (0,0045)		Total sample	20,32358 (0,2060)	
7 + and 5 -	29,93248 (0,0016)		7 + and 5 -	17,41318 (0,0962)	
3 + and 3 -	24,76408 (0,0002)		3 + and 3 -	12,56997 (0,0278)	
CA = Mining and quarrying of energy producing materials			DG = Manufacture of chemicals, chemical products and man-made fibres		
CB = Mining and quarrying, except of energy producing materials			DH = Manufacture of rubber and plastic products		
DA = Manufacture of food products, beverages and tobacco			DI = Manufacture of other non-metallic mineral products		
DB = Manufacture of textiles and textile products			DJ = Manufacture of basic metals and fabricated metal products		
DC = Manufacture of leather and leather products			DK = Manufacture of machinery and equipment n.e.c.		
DD = Manufacture of wood and wood products			DL = Manufacture of electrical and optical equipment		
DE = Manufacture of pulp, paper and paper products; publishing and printing			DM = Manufacture of transport equipment		
DF = Manufacture of coke, refined petroleum products and nuclear fuel			DN = Manufacturing n.e.c.		
			EA = Electricity, gas and water supply		

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**ENDNOTES**

<sup>1</sup> Nevertheless, this hypothesis has been questioned by other authors, who point out that the shape of a monetary union also reinforces bilateral trade among its members. This effect would result in higher levels of correlation in their respective cycles and a lower probability of experiencing asymmetric shocks (Frankel and Rose 1998).

<sup>2</sup> We have not been able to include the services in our analysis due to the lack of statistics in Spain in this regard.

<sup>3</sup> This result is unconvincing since Central Bank decisions will always cause a single (and common) monetary shock, which undoubtedly might produce different effects on certain sectors; but it is the response that might differ across sectors not the shock itself.

<sup>4</sup> Nevertheless, Dedola and Lippi (2005: 1551) point out that, the estimated parameter associated with the instantaneous response of the production sector monetary shock is not far from zero, and such an inconsistency would not be relevant in their model.

<sup>5</sup> It is important to note that our study is only considering the unanticipated monetary policy, that is, the monetary policy “surprises” or exogenous shocks, which is the common practice in the current empirical literature on sectoral effects of monetary policy (Ganley and Salmon 1997, Hayo and Uhlenbrock 2000, Peersman and Smets 2002 and Dedola and Lippi 2005). However, we are aware that the monetary policy decisions also have a systematic component which is at least as important as the ‘monetary surprises’ (McCallum 2001: 38), but its identification usually requires the

estimation of structural models which are highly demanding in terms of data (not available to the authors).

<sup>6</sup> The reasoning behind the inclusion of the German interest rate is to acknowledge Spain's membership in the EMS and the "anchoring" role performed by the German economy within the EMS. We also considered the insertion of the M3 due to the importance attributed by the Bank of Spain to monetary aggregates (in its monetary strategy) during most of the period under study (Bank of Spain 1997: 89-119).

<sup>7</sup> The reasoning for using this period is to avoid the period of monetary instability present during the 70's and early 80's, where monetary policy of the Bank of Spain (BS) focussed on the strict control of monetary aggregates. Starting with the mid 80's the growing financial opening of the Spanish economy, with its membership in the EMS, and especially the liberalization process of the Spanish financial system created important changes in the strategy followed by the BS, resulting in the growing importance of interest rates in the execution of monetary policy. We chose 1988 as the beginning date for this second period, thus avoiding the important variability experienced in interest rates during 1987 (see Bank of Spain 1997 for further details, particularly pages 89-119).

<sup>8</sup> By acting this way we assume unexpected monetary policy actions do not have an instantaneous impact on output (IPI) and prices (CPI).

<sup>9</sup> Data restrictions limit the estimates for the industrial activity branches to the period 1991-1998.



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<sup>10</sup> This parameter was calculated as the result of multiplying, for each region, the estimated sensitivity from the RF-shock (table 3) for each one of the industrial subsections by its respective participation in the regional industrial GDP in 1998.

<sup>11</sup> The values of both parameters are shown in Table A.1 of the appendix.